SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1903.

GENERAL PHYSICS.

276. *Planigraph.* **E. Marzorati.** (Zeitschr. Instrumentenk. 22. pp. 209–212, July, 1902.)—The distance of a point is found from the apparent size of a surveyor's rod as measured on a vertical scale attached to the instrument. The motion of the telescope in gauging the height of the rod is transmitted by wheelwork to cause the horizontal motion of a pointer which gives the required distance on a graduated scale. By pressing a button on the pointer the position of the distant point is marked on a plan, and the ground can thus be mapped, using a scale of 1 : 2,000, up to a distance of 260 m., in a very short time. G. E. A.

277. *Relations between Physical Quantities.* **F. Pettinelli.** (Journ. de Physique, 1. pp. 594–599, Sept., 1902. Cuneo, p. 1–70, 1902.)—Relations between physical quantities are arrived at as follows: Quantities in which there is a likelihood of relationship are taken and stated dimensionally. Then any combination having no dimensions ought to give the constant relationship if it exists. For example, if c be the coefficient of cubical compressibility of a liquid, m its molecular weight, d the density, T temperature, then $cd\mathrm{T}/m$ is non-dimensional. (T receives the dimensions of energy.) A table of values is given, T being the difference of critical and actual temperatures of the liquid. The constant so arrived at ranges from 256 to 281 for seven liquids. In this way the author arrives at 55 new laws, verified more or less closely by the experimental data. A more complicated example is: Let y be the viscosity coefficient of a liquid, m the molecular weight, d the density, T_c the critical temperature, T the actual temperature, then $ym^{\frac{1}{6}}/d^{\frac{2}{3}}(\mathrm{T}_c - \mathrm{T})^{\frac{1}{2}}$ is constant. J. W. P.

278. *Cohesion of Liquids.* **Leduc and Sacerdote.** (Soc. Franc. Phys., Séances, 2. pp. 76–92, 1902.)—This continues the work referred to in Abstract No. 1494 (1902). Gay Lussac's experiment is first considered and the erroneous nature of its interpretation is pointed out. The theory of this experiment is considered, from the surface-tension point of view, and experiments are described verifying this theory for water and mercury. Experiments on cohesion are then described. These are of two classes, depending (1) on capillary ascension in a vacuum, (2) on the use of truncated barometers. The results from (1) show that the cohesion of water is greater than a pressure of 23 cm^2 of water. In the second a column of 5·3 m. was still below the limit of cohesion. J. W. P.

279. *Surface Tension of Mixtures of Normal Liquids.* **E. Herzen.** (Archives des Sciences, 14. pp. 232–260, Sept., 1902.)—The method employed is that of Ramsay and Shields, in which the rise of the liquid (in contact with its saturated vapour) in a capillary tube is measured. The tube has an internal radius of 0·01738 cm. The numerical tables give the following data: (1) the percentage composition of the mixture, (2) the capillary ascension, (3) the density of the liquid, (4) the surface tension deduced from (2) and (3), (5) the surface tension calculated from the law for mixtures. In the theoretical part there are given for the mixtures, (1) the molecular proportions, (2) the mean molecular weight, (3) the mean molecular volume, (4) the superficial molecular energy. Mixtures such as aniline and toluene, benzene and ethyl acetate, aniline and benzene, benzene and nitrobenzene, are considered. It is found that the formula of Lorentz, $a_x = a_1x^2 + 2\sqrt{a_1a_2}x(1-x) + a_2(1-x)^2$ gives the surface tension of the mixture in terms of those of its components where x and $1-x$ are the molecular proportions of the components, and a_1, a_2 are the attractions of the respective constituents. J. W. P.

280. *Strength of Concrete.* **Considère.** (Comptes Rendus, 135. pp. 337–341, Aug. 18, 365–368, Aug. 25, and pp. 415–419, Sept. 8, 1902.)—Experiments were made with a specimen 2 m. long and 1 dm. square in section having four wires of total section 113 sq. mm., one near each corner; the mixture being in the proportion of 3 of Portland cement to 4 of sand. Before loading the wires are in compression, and the concrete in tension, on account of the shrinkage of the latter; after passing the yield point of the concrete, the autographic diagram is practically a straight line parallel to the load due to extension of the iron wires, the force contributed by the former being practically constant for a considerable range of extension. The total load applied was 8,800 kg., the strength of the concrete alone being about one-third of this. There is also a theoretical investigation of the gain in resistance to compression by having a steel wire embedded in the concrete, together with an account of some experiments on the same. H. R. C.

281. *The Mt. Pelée Eruptions.* **A. Lacroix, R. de l'Isle,** and **Giraud.** (Comptes Rendus, 135. pp. 377–391, Sept. 1, and pp. 419–431, Sept. 8, 1902.)—As delegates of the French Academy, the authors spent six weeks on Martinique from June 20, 1902, paying also a short visit to St. Vincent. The first paper describes the crater of the Montagne Pelée (they could not descend into it), the unimportant topographical changes, the ravages by the sea, and the eruption products. The fumaroles were arranged in the continuation of the cleft in the crater; there were no important fissures besides, nor other proper earthquake phenomena. The fumaroles were partly very hot, up to 410° C., and those issuing from the rivers powerful; some contained sulphurous vapours, others—but not those near the crater—also ammonium chloride. There had been ejections of mud, not of lava. The fall of ashes which darkened the vapour clouds was not considerable. Large blocks and lapilli (andesite-hypersthene) were found near the crater only, the latter being either quickly washed away by the rain, or united with the other products to conglomerates. The barometer at Fort de France fell 3 mm. and less during each important eruption.

The second paper describes the destruction of St. Pierre, which was due not to big stones or to incandescent ashes in the first instance, but chiefly to an outburst of vapours and their mechanical, caloric, and physiological effects. Near the volcano, for 2 or 3 km., everything was razed and burnt or charred; further away, the buildings were not destroyed, nor burnt, and the people only asphyxiated; the wounded were covered with silicate mud. The heat had nowhere melted thin copper wires; the sulphur in the gases had not converted metals into sulphides; hydrochloric acid, nor other acids, have not been found. The electric phenomena were very remarkable. The combustion may partly have been due to the presence of sulphuretted hydrogen, hydrogen, and hydrocarbons, which would also explain the asphyxiation. H. B.

282. *The Saloniki Earthquake of July 5, 1902.* **Christomanos.** (Comptes Rendus, 135. pp. 515-516, Sept. 29, 1902.)—Like other earthquakes in the district of Saloniki and Chalcidike, this earthquake seems to have been of a tectonic character. It lasted days, and as it was felt over a large area the origin was probably at considerable depth. The epicentre is supposed to have been between Saloniki and Gouvesno. The paper gives hardly any particulars. H. B.

283. *Collecting Water Samples at Various Depths.* **E. B. Phelps.** (Technology Quarterly, 15. pp. 229-231, June, 1902.)—For the determination of dissolved oxygen, the author has found the following sampling apparatus convenient. Two stoppered bottles, connected by tubes, are mounted in a wire cage in such a way that, on lowering the cage, the inrushing water would first fill the smaller bottle and then flow over into the larger bottle; the respective capacities are 250 and 500 cc. When air-bubbles cease to rise, the water in the small bottle will have been renewed three times, so that one may be sure of having the water of the desired stratum in the bottle. H. B.

284. *Correlation between the Barometric Heights at Stations on the Eastern Side of the Atlantic.* **F. E. Cave-Browne-Cave,** with **K. Pearson.** (Roy. Soc., Proc. 70. pp. 465-470, Aug. 22, 1902.)—The author has analysed the morning barometric readings of Bodo, Floro, Skudnesnaes, Valencia, Lisbon, and Funchal, for the twenty years, 1879-98, further of Sierra Leone (ten years), and St. Helena (six years), and is studying the barometric records from the Western Atlantic stations at Toronto, Halifax, New York, Wilmington, and Key West. It resulted that winter and summer months (equinox to equinox) should be distinguished, and the results are worked out for two groups of ten years each. A correlation in Karl Pearson's sense is found to exist for the stations of the Eastern Atlantic. A positive correlation (high barometer at the two stations for the same day) becomes negative (high barometer at one station, low at the other) at a certain distance, and may once more become positive and negative at greater distances, thus giving a wave curve with decreasing amplitudes. The curve cuts the abscissa at points of no correlation or nodal points. Lisbon is positively correlated with Valencia and negatively with Bodo, Valencia positively with Bodo, and negatively with Funchal at a considerable distance to the south. H. B.

285. *Meteorology of Edinburgh, III.* **R. C. Mossman.** (Roy. Soc. Edinburgh, Trans. 40. 3. pp. 469–509, Sept. 5, 1902.)—These tables bring the data referring to the local climate, formerly reduced down to the end of 1896, to the end of 1900. New monthly and yearly averages have been completed for the periods 1891–1900, 1851–1900, and longer periods of 137 years (mean temperature), 131 years (mean barometer), &c. A table of errata to Part II. is added. The tables concern sunshine, partial drought, decennial means of solar radiations for each day of the year, winds, snow, hail, thunderstorms, fogs, halos, auroræ, and also the price of wheat since 1801. A chronological list of remarkable phenomena, including eclipses and plagues observed in Edinburgh since 1497, is also given. H. B.

286. *Diurnal Variations of Atmospheric Refraction.* **V. E. Boccara.** (N. Cimento, 4. pp. 192–203, Sept. 1902, and Memorie della Società degli Spettroscopisti Italiani, vol. 31, 1902.)—The paper gives the results of further observations made at Palermo in the spring of 1902, confirming those previously obtained at Catania. As before, the altitude of the sea-horizon, with reference to a fixed near object, was observed to change in a uniform manner during the day. The author attempts to explain his results on Maxwell and Bartoli's hypothesis of a mechanical pressure exerted by light. He finds "that refraction diminishes with increase of barometric pressure" [?], and hence infers that it diminishes with increase of light pressure. He then accounts for the maxima at sunrise and sunset in his refraction curve by the small pressure then exerted by the solar rays owing to their obliquity. Similarly he explains the small range of refraction on cloudy days by the scattering, and consequent diminished variation in obliquity, of the light rays. The mean value of n obtained from the observations is 0·1418. [See also Abstract No. 647 (1902).] A. E.

287. *Total Eclipse of the Sun, May* 28, 1900. **J. N. Lockyer** and others. (Roy. Soc., Phil. Trans. 198. pp. 375–415, April 7, 1902; also Roy. Soc., Proc. 67. pp. 337–346, Jan. 8, 1901.)—This paper contains the detailed reports of the various sections of observers on the Solar Physics Observatory expedition at Santa Pola. Photographs of the corona were successfully obtained with a 4-in. Cooke photovisual objective of 16-ft. focal length. Reproductions of these are given, with an important comparison between the coronal structure photographed at Santa Pola, and that obtained by Langley at Wadesboro, U.S., about two hours previously. No indications of change during that period are discernible. The spectra of the solar surroundings were photographed by two 6-in. prismatic cameras, having one and two objective prisms respectively. Examples of these are given, showing the detailed variations in the chromospheric and coronal spectra. [See also Abstract No. 2151 (1900).] C. P. B.

288. *Solar Eclipse, May,* 1901. *Report of Massachusetts Institute of Technology Expedition to Sumatra.* **A. E. Burton.** (Technology Quarterly, 15. pp. 9–50, March, 1902.)—The station selected by this expedition was near Sawah Loento, and the programme included photography of the corona and prominences, magnetic observations, photography of the shadow bands and also pendulum observations. In the report are reproduced a photograph of the prominences taken at time of second contact, and a drawing of the corona and disturbances from a negative which was given 20 seconds' exposure. All the other photographs were badly fogged from various reasons.

The observations of the change in declination of the magnetic needle showed that during the eclipse the declination increased, while the usual change at that time of day was in the opposite direction. A report is also appended on the results of the pendulum observations including a set made at Singapore. E. C. C. B.

REFERENCES.

289. *Roller Extensometer.* **G. C. Henning.** (Amer. Soc. Mech. Engin., Trans. 23. No. 943. pp. 594–601; Discussion, p. 602, 1902.)—This is a description of a roller extensometer in which, instead of having mirrors attached to the rollers, there is an aluminium arm carrying a vernier over a graduated arc which is attached to the same frame as the roller bearings. H. R. C.

290. *Meteorological Observations Made at Saint-Maurice from December,* 1901, *to March,* 1902. **R. Gautier.** (Archives des Sciences, 14. pp. 303–309, Sept., 1902.)

291. *Some Phenomena which Suggest a Short Period of Solar and Meteorological Changes.* **N. Lockyer** and **W. J. S. Lockyer.** (Roy. Soc., Proc. 70. pp. 500–504, Sept., 1902.)—[See also Abstract No. 198 (1903).]

292. *The Organisation of Automatic Spectroscopes at the Observatory at Meudon for the Study of the Radial Velocity and the Density of the Solar Chromosphere.* **H. Deslandres.** (Comptes Rendus, 135. pp. 500–503, Sept. 29, 1902.)—This is a plea for a regular photographic record of the variable elements in the sun—its surface, and the velocity and density of the chromosphere. The note contains a brief mention of the spectroscopes at Meudon used for the work on the chromosphere. E. C. C. B.

293. *Rotation of Uranus as Determined by the Spectroscope.* **H. Deslandres.** (Comptes Rendus, 135. pp. 472–475, Sept. 22, 1902.)—The author describes an application of his method as described in the same journal [120. pp. 417 and 1155 (1895)] to the planet Uranus. The photographs taken were not very good, and the only results to be drawn from them are that the planet rotates in the retrograde sense like its satellites, and that the method under better conditions would give a definite result as to the period. E. C. C. B.

LIGHT.

294. *A Portable Range-finder.* **G. Forbes.** (Roy. Soc., Proc. 70. pp. 347–358, Aug. 9, 1902.)—A range-finder is described as in a previous paper [see Abstract No. 658 (1902)]. The errors of the base and its hinge are then investigated, and it is shown to be possible to observe the object in any part of the field of view without the error amounting to 2 per cent. if the inclination of the axes of the prisms to each other does not exceed 1′. Appended are certified tests of the instrument, made at Cape Town, in which the errors in estimating distances up to 3,000 yards varied between 0·1 and 3 per cent. G. E. A.

295. *The Incandescent Mantle.* **A. H. White** and **A. F. Traver.** (Soc. Chem. Ind., Journ. 21. pp. 1012–1017, Aug. 15 1902.)—The temperatures of the flame and mantle are here investigated and the relation between temperature and illumination is examined. Le Chatelier thermocouples were employed, and a correction for heat lost by radiation from these was arrived at by taking temperatures for different diameters of wire, and then proceeding (by continuing the curve) to the infinitely thin wire. The conduction and correction losses are also eliminated, so that the thermocouples gave with great certainty the temperatures of the mantles they were in contact with. Tables of figures and curves are given, showing for various mantles the inside temperature, outside temperature, heat conveyed to unit area of mantle per hour, heat conveyed from unit area per hour, heat transformed, illumination per unit area. The temperature of the commercial mantle is from 1,500–1,600°. For different mantles the illumination depends in a greater degree upon the composition than upon the temperature of the mantle. The efficiency of the mantle is due to a solid solution of the oxide of cerium in the oxide of thorium, and this substance is capable of transforming the heat of the flame into light more economically than a black body or any other substance yet known. J. W. P.

296. *Reflection of Light from Magnetised Mirrors.* **P. Camman.** (Comptes Rendus, 135. pp. 286–288, Aug. 4, 1902.)—Experiments are carried out in order to verify C. H. Wind's theory of reflection of light from magnetised metallic mirrors (Archives Néerlandaises, vol. 1. Ser. 2, 1897) for the case in which the magnetisation is perpendicular to the plane of incidence, the theory requiring that there should be no effect on light polarised in the plane of incidence, but that the reflected ray should be changed in phase and amplitude when polarised perpendicular to this plane. A quarter-wave plate and an analyser were employed in measuring the change of phase of the two constituents of the elliptically polarised reflected beam and the change in azimuth, the mirrors consisting of two plane parallel pieces of iron held between the pole-pieces of two electromagnets which produced a field of 1,350 c.g.s. Tables of calculated and observed values of the changes in the above quantities are given, and the results are considered a satisfactory confirmation of Wind's theory. G. E. A.

297. *Reflection of Light by a Charged Metal Surface.* **P. V. Bevan.** Cambridge Phil. Soc., Proc. 11. pp. 438–444, Aug., 1902.)—A charged metal consists of the metal itself in the ordinary condition with a layer on its surface of corpuscles which are associated with the electric charge. The author supposes the layer with the charge to be of a thickness extremely small compared with the wave-length of light, and calculates the change of phase in the reflected light due to the charge. If the surface be negatively electrified, the surface-density of the electrification to produce a change of phase of a hundredth of a wave-length in the reflected light must be of the order of one million and a half c.g.s. electrostatic units. The effect is thus so small that it would probably escape detection with the present methods of detecting difference of phase. For positive electrification the surface-density necessary to produce a given phase-difference is greater than for negative in the (large) ratio e/m for the negative metal to e/m for the positive.

W. S.

298. *Penetration of Totally Reflected Light into the Rarer Medium.* **E. E. Hall.** (Phys. Rev. 15. pp. 73–106, Aug., 1902.)—It is well known that if two glass prisms be pressed together, and if the thickness of air film between them be small enough, total reflection no longer takes place in the air-layer, and light is transmitted at all angles of incidence. The phenomena are best seen when one of the prisms has a convex surface; this gives an elliptic spot of light whose major axis changes with the angle of incidence, the intensity, the wave-length, and (if the incident light be plane polarised) with the plane of polarisation. The author used two rectangular prisms, one of flint and one of crown glass; the side faces were square and plane, the hypotenuse surfaces were ground accurately spherical with a radius of curvature of about 8 m. Along with one of those prisms was used a 90° prism with a plane hypotenuse surface, the two being clamped together with the air or other film between their hypotenuse surfaces; the clamp was provided with set screws for regulation of the pressure and position of contact. The clamp containing the prisms was set with the prism edges vertical on the table of a spectrometer. The source of light was the illuminated slit of the collimator, and after traversing the prisms the light passed through a ground glass screen, a Nicol prism, and thereafter into a telescope with micrometer eyepiece, whereby the vertical diameter of the transmitted spot of light was measured. In all cases observations were made with the light polarised (1) in, and (2) at right angles to the plane of incidence. The light was incident on the prism whose hypotenuse face was plane, and the angle of incidence on the prism face could be determined to within a few seconds. The thickness of the layer between the prisms was determined by calculation from the observed diameter of the interference rings for several angles of incidence less than the critical angle, a calibration curve being plotted with diameter of rings as ordinates and thickness of film as abscissæ; from this curve the thickness of film penetrated could be obtained from the diameter of the transmitted spot of light; a new curve was plotted every time the prisms were put together. In working with films whose index of refraction differed little from that of the glass, a modified arrangement of the prisms was used. The first set of results refers to a white light source; the author gives curves having the angles of incidence on the film as abscissæ, and the thicknesses of film in thousandths of a millimetre through which light was transmitted to the second prism as ordinates; the curves have the same form for all substances used, and if produced would intersect at the point whose coordinates are 90°, 0; the observations refer to the following combinations: (1) Flint glass, air, flint glass; (2) crown glass, air, crown glass; (3) flint glass, water, flint glass;

(4) crown glass, water, crown glass; (5) flint glass, benzole, flint glass; (6) crown glass, turpentine, crown glass; (7) crown glass, benzole, crown glass. In order to compare the results of experiment with theory the author used also a monochromatic source. He gives tables of results for the combination crown glass, air, crown glass for lights of four different wave-lengths (red, yellow, green, violet); also for the same combination with the same yellow light when the light before reaching the collimator slit passed through a yellow glass which was found by the usual photometric method to absorb approximately one-half the light of this wave-length. He finds that doubling the intensity increases the penetration by 1·18 times its original value, the increase being the same for either plane of polarisation; the ratio is, however, not constant, but varies with the magnitude of the original intensity; no simple relation expresses the variation of penetration with the intensity or with the wave-length of the incident light. The author next deduces the law that, *ceteris paribus*, the penetration is a function only of the index of refraction of the film; this he proves from the fact that the same results were obtained from a film of wood-alcohol as from a film of salt solution of such density as to have the same index of refraction. The next set of results renders it "highly probable" that both for a water film and an air film the penetration is greater for the direction flint glass, film, crown glass, than for the reverse direction; this is in qualitative agreement with Quincke's observations. As the index of refraction of the third medium increases, the distance to which light penetrates the film decreases; as the relative index between the first and second media decreases, the penetration increases; the same relation, therefore, exists between the second and third media as between the first and second. The penetration was also examined in the film of a substance showing anomalous dispersion (fuchsine), and the results are throughout qualitatively the same. The author finally examines the transmitted and reflected light with a Babinet compensator, and draws the following conclusions: (1) If the incident parallel light be plane polarised in any azimuth, both the transmitted and "totally reflected" light are elliptically polarised; (2) the phase difference, in both the transmitted and the reflected light, is independent of the intensity; (3) the phase difference decreases as the refractive index of the film increases; (4) the phase difference is the same whether the order be flint glass, air, crown glass or crown glass, air, flint glass; (5) the phase difference in the transmitted system increases with increase in thickness of the layer penetrated; (6) as the angle of incidence increases, the phase difference increases from zero at the critical angle to a maximum, and then decreases to zero for an angle of incidence of 90°, the maximum value occurring at the angle of incidence for which the penetration is independent of the plane of polarisation; (7) the direction of the axes of polarisation in the transmitted light are parallel and perpendicular to the plane of polarisation of the incident light. Finally the author shows that his results agree closely in every detail with the electromagnetic theory of light. W. S.

299. *Fringes of Thin Films in the Neighbourhood of Total Reflection.* **J. M. de Lépinay.** (Journ. de Physique, 1. pp. 491–498, Aug., 1902.)—Jamin, in a memoir on Newton's Rings (Ann. de Chem. et de Phys., Ser. 3, xxxvi., p. 158, 1852), remarks on the curious aspects presented by these fringes in the region of total reflection with monochromatic light (one at least of the surfaces bounding the film being a face of a prism). He adds that they are generally difficult of observation, owing to the different rings being formed at different distances from the eye. The present author discusses a method by which this difficulty is avoided. The angle of incidence must be unique and well determined—a condition he secures by placing the fringe-producing system on the table of a goniometer, the slit being exactly at the focus of the collimating lens, and adjusted very truly normal to the plane of incidence. He shows photographs taken with an hour's exposure by the light of the green mercury arc, on isochromatic plates sensitive to yellow and green. The prism was an equilateral one of flint, index 1·723. Near a line through the centre of the rings, parallel to the plane of incidence, each dark fringe is bordered on the side away from the light by a very narrow brilliant fringe, followed by a series of narrow bands alternately dark and light. A striking impression of relief is produced. Near a line through the centre perpendicular to this the rings preserve their normal aspect of narrow black bands on an almost uniform background. When the incidence is very near the limiting angle the above phenomena present some curious divergencies. The dark spot is not exactly central, and only half-rings are seen, which present a complex appearance near their broken ends. Analogous phenomena may be seen in the case of a thin wedge, with this difference, that the complexity is seen when the refracting edge is normal to the plane of incidence; the disappearance of part of the fringes occurs when the edge is turned towards the source of light, and the incidence is nearly limiting. The phenomena can be accounted for theoretically, the explanation depending on the complexity of the law for the difference of path. Take, for instance, the case of a thin prismatic lamina with its refracting edge normal to the plane of incidence and turned towards the reflected light. If δp be the difference of path for a ray after $2p + 1$ interior reflections, we have $\delta p = 2pe(\epsilon + p\alpha)$, e being the thickness at the point considered, α the angle of the thin prism, and $90 - \epsilon$ the angle of refraction. Here α cannot be neglected as is usually done, since it is of the same order as ϵ. A. E.

300. *Reflection and Refraction by a Transparent Body having Rapid Translation.* **J. Boussinesq.** (Comptes Rendus, 135. pp. 269–273, Aug. 4, and pp. 309–314, Aug. 11, 1902.)—This is a continuation of the paper dealt with in Abstract No. 206 (1903). The author establishes the equations which hold at the boundary of two homogeneous media, and deals with the amplitude of vibration in the incident, reflected, and refracted rays. The construction for the reflected and refracted rays is found to be independent of the motion of translation; the rotation of the plane of polarisation of the refracted ray is affected thereby (in agreement with certain experimental results obtained by Fizeau). W. S.

301. *Blue Colour of the Sky.* **G. Zettwuch.** (Phil. Mag. 4. pp. 199–202, Aug., 1902. Extracts from a thesis for the University of Rome.)—The original paper, which contains a long table of results, is divided into three parts. Part I. is historical, Part II. deals with the present state of the problem, and Part III. describes the author's experimental researches. These were directed towards the verification of Rayleigh's theory, according to which the intensity of the various radiations due to particles small in comparison with λ, the wave-length of light, varies as $1/\lambda^4$. The apparatus consisted of a Krüss spectroscope fitted with a Vierordt double-slit collimator, which enabled it to be used as a spectrophotometer. As the results varied with the local conditions, it was thought more instructive to calculate the value of n which would satisfy an assumed law $1/\lambda^n$ instead of $1/\lambda^4$. The

following are some of the author's conclusions: (1) It is evident that we have to deal with a highly variable phenomenon, as the light reflected from the sky, and coming from the same point of it, is of variable composition. The predominant radiations are those of short wave-length, but their proportion is not even approximately constant. (2) On clear days the value of *n* increases continuously with the zenith distance of the sun, its minimum appearing to coincide with the minimum daily Z.D. (3) For large Z.D.'s, 79°–90°, *n* increases fairly rapidly. (4) For Z.D.'s near 90° the results show no great divergences from Rayleigh's formula, and tend towards it rapidly. As regards the zenithal light, its observed composition cannot be represented by a single general formula, but the results do not permit the conclusion that it never satisfies Rayleigh's law. Under certain favourable circumstances the value corresponding to Rayleigh's law is undoubtedly continuously approached, and in some cases surpassed. The most saturated blue occurs at points which are 90° from the sun, and therefore not at the zenith. The blue appears to be less pronounced at Rome than in England and France. (5) The perturbing cause which produces variations in the composition of the diffused light is, in most cases, undoubtedly cloud. Even a few very thin clouds have a surprising disturbing effect as the zenith is approached. The author remarks that observations of the blue light emitted laterally by a suitable turbid medium, and in particular the artificial sky-blue of Bock, have yielded uniform results. The values of *n* calculated from Bock's observations satisfy the requirements of Rayleigh's theory. At present the controversial choice lies between the colour proper of the air and Rayleigh's theory, which, in the present state of science, is the only one capable of explaining certain important facts. The author supports Pernter's view that it is the turbidity of the air which gives rise to the blue colour, and that the weak colour proper of the air—if it exists—contributes nothing towards it. Variations in the number and size of the particles which give rise to the turbidity, and in the invisible strata of water vapour, explain, sufficiently in accordance with Rayleigh's theory, the discrepancies among the results. A. E.

302. *Lecture-room Demonstrations of Astigmatism and of Distortion.* **W. S. Franklin.** (Phys. Rev. 15. pp. 119–120, Aug., 1902.)—The astigmatism of a lens for an oblique pencil may be shown subjectively by looking obliquely through a magnifying glass at the rulings on a piece of cross-section paper. If the lens be adjusted to show one set of rulings distinctly, then the other set will be indistinct. The astigmatism may be shown objectively by projecting on a screen an image of a cross-ruled transparent plate, the projecting lens being turned so that its axis makes an angle of 20° or 30° with the optical axis of the lantern. A small part only of the plate should be used, the rest being cut off by a diaphragm, and the lantern should be adjusted so that the light from the condenser may be focused on the projecting lens. The error of a lens known as distortion may also be demonstrated, and the principle of the rectilinear lens shown, by means of the projection lantern. It should be remembered that the distortion produced by a simple lens is small except when a stop is used at some distance from the lens. Instead of using a stop it is convenient to adjust the lamp so that the condenser focuses the light at some distance in front of, or behind, the projection lens, the distance of this focus corresponding to that of a stop. A large field angle must be used. Under these conditions the image is distorted. If the focus of the condenser lies in the plane of the projecting lens the image is not distorted. In the symmetrical rectilinear doublet the stop is midway between the lenses, and the distortion of one lens compensates that of the other. A. E.

303. *Influence of Solvents on the Rotation of Optically Active Compounds. III. and IV. Influence of Aromatic Hydrocarbons on the Rotation of Ethyl Tartrate.* **T. S. Patterson.** (Chem. Soc., Journ. 81. and 82. pp. 1097–1140, Aug., 1902.)—The following table shows the relationships existing between the specific rotatory power of infinitely dilute solutions of ethyl tartrate, and the other physical properties of the solvent. The close interdependence between the rotatory power and molecular specific volume of the solute and between rotatory power and the surface tension of the solvent is shown by the accompanying curves. No relationship appears to exist between the rotatory power and the degree of association of the dissolved ethyl tartrate.

Solvent.	$[\alpha]_D^{20^\circ}$ Inf. diln.	M.-S.-V. of Ethyl Tartrate at 20° inf. diln.	Latent Heat of Vaporisation at Boiling-point.	Capillary Rise in Tube 1 mm. Circumference in cm.	Surface Tension N.	Dielectric Constant.
Water	+ 26·2°	157·7 c.c.	536	7·502 (100°)	337	80 (20°)
Methyl alcohol ..	11·5	159·3	267	3·209 (64·2°)	59·8	35·9 (13°)
Glycerol	10·6	163·3	158·4	—	—	{ 16·5 { 56·2
Ethyl alcohol	9·1	164	205	3·005 (78°)	38·5	26·7 (14°)
n-Propyl alcohol	7·4	167·5	166	2·964 (97°)	29	22·6 (13°)
iso-Butyl alcohol..	6·53	170·3	—	2·775 (106·4°)	21·7	18·9 (13°)
sec-Octyl alcohol..	5·24	174·3	—	—	—	—
Benzene	6·1	175·1	93	3·295 (80°)	27·3	2·21 (7·1°)
Toluene	4·6	174·8	83·6	2·982 (109·8°)	20·1	2·37 (16·3°)
o-Xylene	2·7	176·8	—	2·788 (141°)	16	2·58 (14·1°)
m-Xylene	1·8	176·5	78·3	2·788 (139·2°)	15·9	2·34 (19°)
p-Xylene	0·7	176·1	—	2·783 (138·1°)	15·8	2·23 (19°)
Mesitylene	− 3·0	177·4	71·8	2·565 (165°)	12·6	2·30 (14·4°)

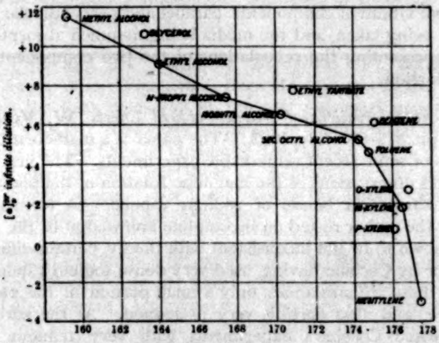


FIG. 1.

Unlike the other hydrocarbons naphthalene (at 70° C.) causes a very great *increase* in the specific rotatory power of ethyl tartrate, the value of which for an infinitely dilute solution, $(\alpha)_D^{70} = 31{\cdot}6^\circ$, being even greater than in aqueous solution; unfortunately the molecular specific volume of the tartrate could not readily be determined. A number of the solutions examined exhibit, with changing concentration, both a maximum and minimum specific rotatory power; thus in benzene for $p=0\,(\alpha)=6{\cdot}0^\circ$, for $p=10\,(\alpha)_D=6{\cdot}8^\circ$, for $p=55^D(\alpha)_D=+6{\cdot}2^\circ$ and for $p=100\,(\alpha)_D=7{\cdot}7^\circ$. Similar curves are given

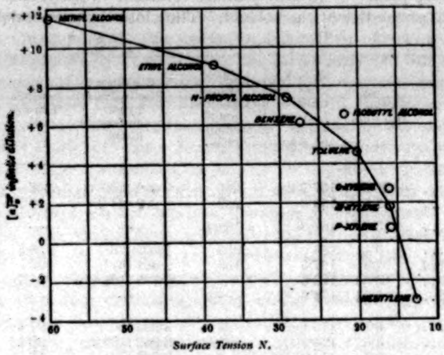


FIG. 2.

by toluene, *o*-xylene and *m*-xylene, but the curve for *p*-xylene, though similarly inflected, does not exhibit any actual maximum or minimum; the curves for mesitylene and naphthalene are not inflected. [See also Abstract No. 1062 (1901).] T. M. L.

304. *Absolute Retardation of Light Vibrations by Reflection.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 259–267, 1902.)—The results of theory are given for the phase retardations of light, due to reflection, two vibration components parallel and perpendicular to the plane of incidence being taken, and the media being assumed absorptive. Figures are given representing the retardations of the two components for various cases of reflection. G. E. A.

305. *Recent Observations of Magneto-optical Effects.* **W. Voigt.** (Ann. d. Physik, 8. 4. pp. 872–889, July, 1902.)—The paper is a mathematical discussion of the results of some recent remarkable experiments. The first section deals with Corbino's observations of the magnetic rotation of the plane of polarisation in the absorption bands of sodium vapour. (A former explanation advanced by the author rested on incomplete knowledge of the facts.) The results are shown to be not inconsistent with theory, certain difficulties being accounted for by Corbino having used very dense sodium vapour and a wide slit. Under these circumstances, only a small portion of the phenomenon is seen at once, and that portion very ill-defined. At the author's request, Zeeman repeated Corbino's experiments with very tenuous vapour and a narrow slit, the field being of such strength that the D lines, and also the reversed lines between them, due to the source, were clearly separated. The results, which are fully described, were in complete accordance with the theory. When very dense vapour was used, phenomena appeared similar to those described by Corbino. According to Zeeman there are several possible explanations of these, and as the conditions in this case are complicated, further observations are required to limit the choice of views. Like Corbino, Zeeman made use of interference bands, which were produced by means of a system of quartz prisms with their edges horizontal. This system was placed close to the slit of a spectroscope, a small nicol being inserted behind the slit on the grating side. The distance between the perforated plates was 4 mm., and the field 18,000 c.g.s. Horizontal interference bands were seen crossing the spectrum in the field of view, and the changes they underwent, when either the vapour density or strength of field was gradually altered, were observed. It was noticed that with constant density the negative rotation decreased with increasing strength of field. In the second section, the author discusses the results of Majorana's successful attempt to find a magnetic analogue to the electric double refraction discovered by Kerr. The complete analogy of the phenomena to the rotation observed in the case of reflection in transparent bodies points strongly to the conclusion that here also we have to deal with an unequal damping of two components, polarised parallel and normal to the lines of force. Majorana's later observations confirm this "magnetic pleochroismus." The phenomena appear to be also akin to the triplets of the inverse Zeeman effect with abnormal distribution of intensity. Hence both may probably be explained by extensions of theory on similar lines. The results of Voigt's mathematical discussion indicate that while, according to the electron theory, the electric field produces polar change in the quasi-elastic forces, the magnetic field produces polar change in the apparent masses of the electrons. A. E.

306. *Prism Spectroscope with fixed Emergent Ray.* **F. F. Martens.** (Deutsch. Phys. Gesell., Verh. 4. 12. pp. 255–258, June 27, 1902.)—The rays from an arc lamp after passing horizontally through a condenser and slit are caused by reflection prisms to pass vertically up through a collimator and down through a telescope, finally resuming the original direction to the eyepiece. The prism which reverses the direction of the ray at the top of the collimator can be turned by means of a micrometer screw so as to bring any desired spectrum line to the cross-wires. G. E. A.

307. *The Spark and Arc Spectra of Europium.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien., Sitz. Ber. 111. 2a. pp. 42–57, 1902.)—The paper contains the lines measured in the arc and spark spectra obtained with Demarçay's Eu_2O_3. The spark spectrum is characterised by a series of very strong lines like the lines of Yttrium or Lanthanum and a great number of weaker and sharper lines like those of Erbium; in the arc spectrum the latter are mostly absent. For these reasons the authors believe that the Eu_2O_3 is not the oxide of only one substance. E. C. C. B.

308. *The Gundelach-Dessauer Röntgen Tube.* **L. Henne.** (Elektrotechn. Zeitschr. 23. pp. 675–676, July 31, 1902.)—This tube, made by the Elektrotechnisches Laboratorium, Aschaffenburg, presents two features: (1) The antikathode is in a tube so that the rays from the kathode, instead of falling on a little surface of the antikathode, meet in a point, and thus make a point radiant; and (2) there is an adjustable spark-gap between the anode and the antikathode. When this spark-gap is open at its full the radiations are hard and penetrating; when it is closed they are soft, feebly penetrating, and chemically active. On adjustment of the spark-gap by aid of a screw, any intermediate character of radiations can be obtained; and when a fluorescent screen is used, the screw can simply be turned until the required image is seen at its best. One tube, therefore, serves all purposes, say through the thorax or through the hand only. A. D.

309. *Induced Radio-activity.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 11. p. 504, Aug., 1902.)—Experiments were carried out to determine whether the induced radio-activity shown by a metal rod after long-continued negative electrification in the open air would occur if the rod were placed in a closed vessel. The closed vessel was a zinc gas-holder 102 cm. high and 75 cm. in diameter ; the vessel was insulated and used as one of the electrodes, the other electrode was a metal tube placed at the axis of the cylindrical gasometer. A potential difference of 800 volts between the cylinder and this rod was produced and the current between the electrodes was measured. This current was "saturated," and was therefore a measure of the total ionisation of the gas in the vessel; if the rod become radio-active, the ionisation and therefore the current would increase. The current was measured before and after the rod was connected for 6 or 7 hours with the negative terminal of a Wimshurst machine. When the gas in the vessel was not exposed to Röntgen rays whilst the rod was negatively electrified, no increase in the current through the gas could be detected. If, however, the gas were exposed to Röntgen rays during the negative electrification of the rod, then an increase of 16 or 17 per cent. in the current took place; this increase being due to some alteration in the rod and not to a change in the gas in the vessel. No increase took place in the current if the rod was positively electrified. When the vessel was not exposed to rays and the rod not electrified, this latter being of various size and materials, approximately the same current was given in all cases. A decided increase of current was caused when filter paper was wrapped round the rod, especially when the filter paper was moist. A large effect was produced when the paper was wetted with brine or alcohol, but the greatest effect observed was got when a solution of H_2O_2 was used. J. J. S.

310. *Radio-active Rain.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 11. pp. 428–430, Aug., 1902.)—Rain when caught in a vessel and immediately evaporated to dryness has been found to impart radio-activity to the vessel in which it was evaporated. There appears to be in the atmosphere a radio-active substance which is carried down by the rain. Ordinary water when evaporated, and rain-water which has been allowed to stand for some hours before being boiled down, do not yield any radio-activity. J. J. S.

REFERENCES.

311. *Engelmann's Microspectral Photometer.* **H. Siedentopf.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 32. pp. 706–710, June 26, 1902.)—An instrument is described in which a Thorp grating is employed to analyse the colours of microscopic objects. G. E. A.

312. *Engelmann's Microspectral Objective.* **H. Siedentopf.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 32. pp. 711–719, June 26, 1902.)—A microscope objective is furnished with a polariser and interchangeable Thorp gratings for examining microscopic objects in coloured light. The theory of the Thorp grating is given in which the ridges are like saw-teeth. G. E. A.

313. *Zeeman Effect.* **C. Runge** and **F. Paschen.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 32. pp. 720–730, June 26, 1902.)—Further numerical details are here given. [See Abstract No. 216 (1903).]

HEAT.

314. *Continuous Vacuum Distillation Apparatus.* **C. F. Mabery.** (Amer. Acad., Proc. 38. pp. 3-5, June, 1902.)—The features to be aimed at in such an apparatus are: (1) Exclusion of air from the hot oil in the still during change of receiver; (2) admission of distillates into still without interruption; (3) admission of air into the receiver before removal of each fraction; (4) exhaustion of receiver for new fraction without connection with still. Diagrams and full description of the apparatus are given. J. W. P.

315. *Comparison of Vapour Temperatures at Equal Pressures.* **J. D. Everett.** (Phil. Mag. 4. pp. 335–338, Sept., 1902. Communicated by the Physical Society.)—The author takes Ramsay and Young's law $t_2/t'_2 - t_1/t'_1 = c(t_2 - t_1)$ where t_1, t_2 denote the absolute temperatures of one vapour at the pressures p_1, p_2; t'_1, t'_2 those of another at the same pressures, and writes it in the form $x/t + y/t' = 1$ where x and y are constants. Hence the law may be stated: If the absolute temperatures at which two vapours have equal pressures are represented by lengths OX, OY laid off along two lines inclined at any angle, the line XY joining these extremities, will, when produced, pass through a fixed point. Comparison with Rankine's formula is made.

J. W. P.

316. *Heat of Vaporisation of Air.* **J. S. Shearer.** (Phys. Rev. 15. pp. 188–191, Sept., 1902.)—Observations on this quantity by Dewar (80), Behn (40), and d'Arsonval (65) show considerable difference. The results of the present determination agree fairly with those of Behn, giving values from 44·02 to 51·7 according to the percentage of oxygen present. The method involved is the evaporation of the liquid air by the heat given off from an electrically heated spiral of German silver wire. The electric energy developed is observed and the rate of evaporation is measured by an Elster gas meter. The air is tested for percentage of oxygen. Comparison with theoretical results using the thermodynamic formula $L = v(_2 - v_1) \cdot \frac{dp}{dt} \cdot t$ is made. J. W. P.

317. *Ebullition of Rotating Water.* **T. C. Porter.** (Phil. Mag. 4. pp. 330–335, Sept., 1902. Paper read before the Physical Society, May 23, 1902.)—The water is thrown into rotation about a vertical axis by means of a spiral stirrer driven by a motor. It is heated by four Bunsen burners, and steam is formed in the region of least pressure, *i.e.*, at the core of the rotating water. The forms of the columns of steam are described and their behaviour during the course of the experiment is considered. A comparison with the columns of the solar prominences is suggested. J. W. P.

318. *Heat of Solution.* **A. Varali-Thevenet.** (N. Cimento, 4. pp. 186–192, Sept., 1902.)—The author, using a Bunsen ice calorimeter, according to Staub's method (Inaugural Dissertation, Zürich, 1890) has investigated the influence of concentration on heat of solution in the case of sodium and potassium nitrates, chlorides, and sulphates; he tabulates his own results and those of other investigators. The results show that for solutions that are not very dilute the heat of solution of a definite quantity of salt diminishes, as the concentration of the solution increases, whilst for dilute solutions the heat of solution diminishes more rapidly than the dilution. In the case of extremely dilute solutions the heat of solution depends solely on the molecular weight of the salt : in fact, we find that the ratio of the heat of solution for zero concentration (obtained by extrapolation) to the molecular weight, tends to the value unity for monovalent radicals, the value two for bivalent radicals. D. H. J.

319. *Calorimetric Measurement of High Temperatures.* **R. Ferrini.** (Rivista Sci.-Industriale, 34. pp. 113–114, Aug.–Sept., 1902.)—The author has collected the following data for use in the calorimetric measurement of high temperatures :—

Final Temperature.	Calories absorbed by a kilogram of		Final Temperature.	Calories absorbed by a kilogram of platinum.
	Platinum.	Nickel.		
100° C.	3·23	12	1100	42·13
200	6·58	24	1200	46·65
300	9·95	37	1300	51·35
400	13·64	50	1400	56·14
500	17·35	63·5	1500	61·05
600	21·18	75	1600	66·08
700	25·13	90	1700	71·23
800	29·20	103	1800	76·50
900	33·39	117·5		
1,000	37·70	134		

The following simply-derived formula may be used with the table : $T = (1 + Q)/13$, where Q is the number of calories required to heat the detached metal from 0° to T°. D. H. J.

320. *Some Thermal Properties of Naphthas and Kerosenes.* **A. H. Gill** and **H. R. Healey.** (Technology Quarterly, 15. pp. 74–80, March, 1902.)—In the present paper the authors communicate the results of several experiments on the specific heat, heat of combustion and vapour density of some of the lighter petroleum oils used for fuel purposes. The oils studied were the so-called 76° Bé. and the 62° Bé. naphthas, and 135° and 150° fire test kerosenes. In the determinations of the specific heat attention is drawn to the considerable variation of this factor with the temperature. The following table gives the values of the specific heat and of the heat of combustion :—

	SPECIFIC HEAT.		HEAT OF COMBUSTION.	
	10°–20°	20°–30°	Cal. per gram.	B.T.U. per lb.
76° naphtha.........	0·5354	0·5555	10·04	18,080
62° naphtha.........	—	0·5045	9·92	17,860
135° kerosene	0·4758	0·4961	9·89	17,810
150° kerosene	—	0·4912	10·10	18,290

A. F.

SOUND.

321. *The Vowel "i."* **L. Bevier, Jr.** (Phys. Rev. 15. pp. 44–50, July, 1902.)—For the vowel sound "i" (as in pit) an analysis is made on lines identical with those followed for other vowels [see Abstract No. 1864 (1902)]. For various reasons this vowel is specially difficult, but a marked region of resonance was observed for frequencies about 1850, also a less important region of resonance about 575. P. E. S.

322. *Auditive Acuteness.* **Marage.** (Soc. Franc. Phys., Séances, 2. pp. 56–65, 1902.)—The author divides instruments for testing the acuteness of hearing into three classes—(1) those which produce noises, (2) those which produce musical vibrations, (3) those which produce vibrations corresponding to the spoken word. In the first class he describes as a type the pendulum of Kämpf; in the second the "acoumeters" of Gaiffe and of d'Arsonval. In the last he gives an account of his own instrument, which consists of five sirens, arranged so as to produce the vowel sounds. The form and relative arrangement of the apertures in the siren plates—triangular and rectilinear—determine the vowels; and the pressure of the admitted air is variable and measurable by a water manometer. The ear to be examined is placed at about 50 cm. from the instrument, and the pressure of the air is gradually increased until the sound is perceived. A normal ear perceives the sound at a pressure of 1 mm. of water. The measure of the auditive power is taken as the reciprocal of the pressure at which the sound first begins to be heard. For auditive powers between 1/2 and 1/10 (thus measured), the deaf person loses many words in general conversation. Loud speaking is necessary for powers between 1/80 and 1/200. Beyond 1/200 special aids are necessary. The power may be different for different vowels. It often happens that for A the power is 1/10, for O 1/30, for E 1/50, for I 1/100. The "siren-acoumeter" has the special advantage of testing the hearing under conditions similar to those of conversation. J. W. P.

323. *Resonance in the Human Ear.* **V. Hensen.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 904–914, July 24, 1902.)—There is in the human ear some resonating apparatus, which is, however, not set in vibration (subject to subsequent damping) by a single impact. It can therefore only sum up the impacts it receives when the vibrations received are pendular; and it does so the more effectively the greater the frequency of these vibrations. Sketch of an explanation, based upon displacements within the cochlea, under which the nerve-ends could only be stimulated for the first time by the second of a series of incident pendular oscillation. The cochlea, therefore, takes no part in the audition of noises; which is in accord with physiological experiment. A. D.

REFERENCE.

324. *Contributions to the History of Musical Scales.* **C. K. Wead.** (Smithsonian Institution, Washington, pp. 421–442, 1902.)

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

325. *The Cavendish Experiment and the Law of Inverse Squares in Electrostatics.* **S. J. Barnett.** (Phys. Rev. 15. pp. 175–177, Sept., 1902.)—This author begins by stating that he has no quarrel with the law of inverse squares, and no objection to make to the accuracy of the Cavendish-Maxwell experiment by which that law is supposed to have been established. But he considers that a fallacy is involved in the deduction of the law from the experiment. He supposes two concentric spheres, A and B, drawn in an infinite homogeneous nonconducting dielectric, and the outer surface A uniformly charged. If the law of force be that of the inverse square, the uniform charge on A has constant potential at all internal points. There is then no internal field. But for any other law the potential is not constant at all internal points, and there is an internal field. But he says there will, even if the law of the inverse square does not hold, be no charge on B, because it is perfectly insulated from A. It appears that the space between A and B is supposed not to be filled with a dielectric capable of polarisation, for if it were there would in this case be an apparent charge on B. The force which in this case exists between A and B could, he says, be reduced to zero by placing a uniform charge on B, but does not explain how any charge on B could produce this result. Cavendish and Maxwell have assumed by implication that the reasoning is valid when A and B are conductors, and connected by a wire. But the writer appeals to experiments of Faraday as showing that a hollow closed conductor screens perfectly the region within it. This fact is usually explained as a deduction from the law of the inverse square, coupled with the property which the conductor has of making the potential constant over its surface. The writer prefers to consider it as a property of the conductor simply. [As we have found salvation in Faraday's inductive method, we should fall from grace if we were to go behind the experiment and again resort to the discarded method of deduction.] No reference is made to Carl Neumann's work on the potential. S. H. B.

326. *Generalisation of Gauss' Theorem.* **S. J. Barnett.** (Phys. Rev. 15. pp. 172–174, Sept., 1902.)—This writer states Gauss' theorem in the form "the electric flux outwards across any closed surface surrounding a charge q (expressed in rational units) is equal to q," or for a single tube of induction the electric flux across all sections is the same. He says it has been proved only for the case of a single homogeneous isotropic medium filling all space outside of the closed surface. In this case the law of the inverse square holds good in its simplest form, and the ordinary proof follows logically. It would not (we are to infer) follow logically if there were any changes in the internal space. To meet this supposed difficulty he proceeds to show that any such external charges could only alter the form of any tube of induction, without altering its strength, and therefore the truth of the theorem is not affected by the presence in the external space of conductors or heterogeneous dielectrics. [The ordinary proof as given by Thomson and Tait assumes the principle of superposition, namely, that we can calculate the flux due to each particle of matter separately, as if no others were present in the field, and then it is shown that matter inside of the space produces the flux q, and matter outside of it produces zero flux. Perhaps the writer's method of using the tubes of force does not require us to assume the principle of superposition. It may be analogous to the use of the differential equation instead of the integral.]

S. H. B.

DISCHARGE AND OSCILLATIONS.

327. *Magnet and Alternate-current Arc.* **C. H. Bedell.** (Elect. World and Engineer, 40. pp. 408–409, Sept. 13, 1902.)—When a magnet is placed at the side of an alternating-current arc, the arc is pulled or pushed aside according as the current is direct or reverse. A permanent record is taken by photographing on a moving film. The current curve does not follow the e.m.f. sine curve, but remains at zero till the e.m.f. of the line equals the counter e.m.f. of the arc. In the photographs shown the gaps due to this cause are considerable.

P. E. S.

328. *Free Electricity in the Kathode Dark Space.* **A. Wehnelt.** (Phys. Zeitschr. 3. pp. 501–503, Aug. 1, 1902.)—Schuster has given the formula $V_x = V_0(1 - e^{-\kappa x})$ as expressing the potential at points in the dark space, where V_x = potential difference between the point and the kathode, V_0 = kathode fall of potential, and κ is a constant. Previous experiments by the author seem to show that this formula holds, but a more careful investigation in the present paper shows that it gives results not in accord with the facts. Having measured the potential fall throughout the dark space, Laplace's equation is used to calculate the amount of free electricity in it. It is found that near the kathode there is an excess of negative electricity; further away the positive predominates. Taking the dark space as a whole there is an excess of positive.

R. S. W.

329. *Formation of Kathode Rays and Röntgen Rays.* **T. Tommasina.** (Comptes Rendus, 135. pp. 319–321, Aug. 11, 1902.)—From observations on vacuum tubes of various forms and different arrangements of the anode and kathode, the author comes to the following conclusions: (1) Diffuse reflection of the anodic flux alone is sufficient to give rise to kathode rays and Röntgen rays. (2) The phenomenon occurs even when the antikathode is connected to the earth. (3) Multiple reflection by the walls of a vacuum tube, at the desired degree of rarefaction, suffices to produce the partial transformation of the anodic flux into kathode rays and into Röntgen rays. The mode of formation of the rays may be regarded in the following way: The electric flux which starts at the anode and is propagated in the rarefied air of the tube follows the lines of force, forming itself its own conductors, which consist of polarised alignments of radiant matter, as takes place in the production of the electric phantom by conducting powders in dielectric liquids where projections or jets of particles are observed. This flux being oscillating causes a periodic destruction of the contacts, which produces vibrations which become visible under the form of luminescence. The kathode mirror is embraced on all sides by the alignments, but its front face receives the densest beam and becomes heated most where the points of arrival are most numerous. This heating increases the rarefaction near the kathode, and gives rise to the dark space of Hittorf. It appears to be in these conditions and in consequence of mechanical modification, partial absorption and diffuse reflection, that the transformation would seem to take place. If this is admitted, the laws of the propagation of the flux of displacement or of polarisation in a dielectric medium may be applied to this category of phenomena as well as the equations of Maxwell. As the infinitely small displacements of a perfectly elastic body follow the same laws, it is possible to pass by the intermediary of the flux of displacement to the vibrations, and it becomes possible to establish a mechanical connection between the electric flux and the radiations. J. J. S.

330. *Reciprocal Influence of Two Neighbouring Oscillators.* **Brillouin.** (Annal. Chim. Phys. 27. pp. 17–26, Sept., 1902.)—An oscillator in this memoir is a small vibrating condenser, whose electrical polarisation is in rapid alternation positive and then negative. It is assumed that the effect due to its oscillation is propagated through the surrounding space with the velocity of light ω. The writer objects to the result obtained by Kiebitz [see Abstract No. 1929 (1901)], that the damping of the wave varies with the distance from the oscillator of a resonator placed in the field. Every wave, he says, has its own proper damping independent of the distance. But what does vary with the distance is the intensity of the waves of higher order which are most damped. If the moment of the oscillator at time t be denoted by $f(t)$, and its axis be parallel to z, the statical potential at distance r from its centre is $\frac{d}{dz}\left\{\frac{1}{r}f\left(t-\frac{r}{\omega}\right)\right\}$. The single oscillator creates, therefore, an electric field whose statical components are—

$$\frac{d^2}{dxdz}\left\{\frac{1}{r}f\left(t-\frac{r}{\omega}\right)\right\},\quad \frac{d^2}{dydz}\left\{\frac{1}{r}f\left(t-\frac{r}{\omega}\right)\right\},\quad \text{and } \frac{d^2}{dz^2}\left\{\frac{1}{r}f\left(t-\frac{r}{\omega}\right)\right\};$$

and there is also the electrodynamic force $-\frac{1}{\omega^2}\frac{d^2}{dt^2}\left\{\frac{1}{r}f\left(t-\frac{r}{\omega}\right)\right\}$ in the direction z. In the whole this gives a radial force—

$$\mathrm{E}=\left(3f+3\frac{r}{\omega}\frac{df}{dt}+\frac{r^2}{\omega^2}\frac{d^2f}{dt^2}\right)\frac{\cos\theta}{r^3}$$

in which f is written for $f\left(t-\frac{r}{\omega}\right)$, and θ is the angle between r and z, and a force in direction z independent of θ—

$$\mathrm{E}'=-\frac{1}{r^3}\left(f+\frac{r}{\omega}\frac{df}{dt}+\frac{r^2}{\omega^2}\frac{d^2f}{dt^2}\right)$$

We now suppose a second oscillator placed in the field at distance r from the first, having an axis making the angle θ' with r, and the angle ϵ with z. If $\mathrm{T}=\frac{r}{\omega}$, the electric force due to the first on the second resolved in the direction of the second is—

$$\mathrm{E}=\frac{1}{\omega^3\mathrm{T}^3}\left\{(3\cos\theta\cos\theta'-\cos\epsilon)\left(f+\mathrm{T}\frac{df}{dt}\right)+(\cos\theta\cos\theta'-\cos\epsilon)\mathrm{T}^2\frac{d^2f}{dt^2}\right\}$$

Both oscillators being initially at rest, the first is set vibrating by a sudden impulse, regarded as a great finite force acting for a very short time, at time $t=0$. From $t=0$ to $t=\mathrm{T}$, the second oscillator remains unaffected, and the first vibrates as if it were alone. But when $t=\mathrm{T}$ the second is set vibrating by the impulse due to the first. From $t=\mathrm{T}$ to $t=2\mathrm{T}$ the first continues to vibrate as if it were alone, but at $t = 2T$ it receives an impulse from the second and so on. The first will receive impulses at $t = 0$, $t = 2T$, &c. In like manner the second receives impulses at $t = T$, $t = 3T$, &c. The calculation of the actual value of these successive impulses in terms of the initial impulse imparted to the first oscillator would be complicated, and is not completely carried out in the present memoir. But the writer hopes to be able to effect the integrations. The writer considers that the discontinuities here considered are such as we may expect to occur in the molecular theory of solids, corresponding to collisions in the theory of gas, or to encounters in the molecular theory of fluids. He points out also the relation of the theory to thermal conductivity, with reference to the works of Riecke and Drude. S. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

331. *Liquid Damping Device for Measuring Instruments.* **V. Arcioni.** (Elettricità, Milan, 21. pp. 518–520, Aug. 17, 1902.)—In the case of instruments with a horizontal axis the device consists of a hollow disc on the axis half full of liquid and containing a diaphragm across the vertical diameter, having one or more holes in it. On being rotated by the deflection the liquid has to flow through the holes in the diaphragm. Toluene is found to be a suitable liquid, the disc being hermetically closed. Various forms may be given to the device, such as a sector or a flywheel with hollow rim. G. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

332. *Measurement of Magnetic Leakage.* **A. Rotth.** (Elektrotechn. Zeitschr. 23. pp. 654–655, July 24, 1902.)—The author describes a null method of measuring the leakage coefficient of a dynamo, in which one or more turns of wire are wound round the field magnet and the armature of the dynamo. One end of each coil is joined to the end of a bridge wire, the other end to two sliding contacts. One of the circuits contains a galvanometer. The sliders are adjusted till on breaking the exciting current of the dynamo no deflection occurs. If two readings are taken with different positions of the sliding contacts, a, b, and a', b', the ratio of the two fluxes is $a - a'/b - b'$. It is in general impossible to find a null position, because the leakage coefficient is not constant but varies with the magnetisation.

The rate of fall, therefore, of the two fluxes is not the same. To obviate this the author breaks the galvanometer circuit by a weight falling through a known distance, and shows how to calculate the time so as to break the circuit at a given field strength. G. H. B.

333. *Graphical Calculation of the Harmonics of any Periodic Function.* **F. Loppé.** (Écl. Électr. 32. pp. 287–290, Aug. 23, 1902.)—By Fourier's theorem the function may be written—

$$f(t) = C + \Sigma(A_m \sin m\omega t + B_m \cos m\omega t).$$

Construct the new curves whose ordinates $f_1(t)$ and $\phi_1(t)$ are given by—

$$2f_1(t) = f(t) + f\left(t + \frac{T}{2}\right) \quad \text{..........................(1)}$$

$$\text{and } 2\phi_1(t) = f(t) - f\left(t + \frac{T}{2}\right) \quad \text{..........................(2)}$$

where T is the period of the function. Then the curve (1) gives the curve representing the constant and the sum of the even harmonics and (2) gives the sum of the odd harmonics. The harmonics of this latter curve, which represents a pure alternating function, can be calculated by the graphical methods previously described [see Abstract No. 105 A. (1903)]. The curve (1) can be further decomposed as follows—

$$2f_2(t) = f_1(t) + f_1\left(\frac{T}{2} - t\right) \qquad \ldots\ldots\ldots\ldots(3)$$

$$2\phi_2(t) = f_1(t) - f_1\left(\frac{T}{2} - t\right) \qquad \ldots\ldots\ldots\ldots(4)$$

(3) represents $C + \Sigma B_{2n} \cos 2n\omega t$, and (4) represents $\Sigma A_{2n} \sin 2n\omega t$. (3) can also be decomposed into—

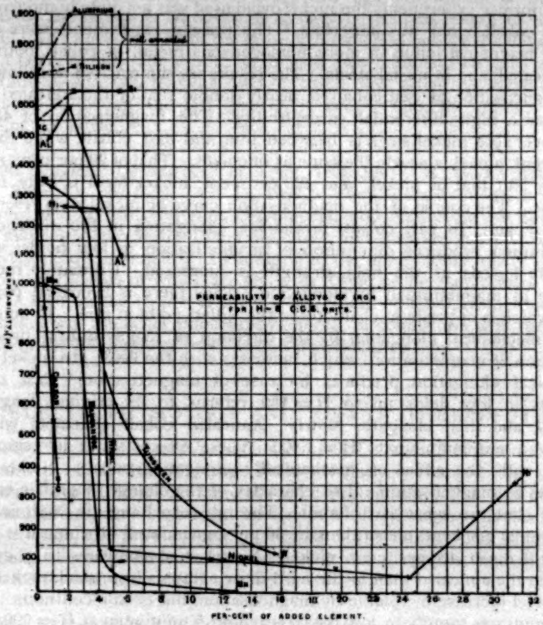
$$2f_3(t) = f_2(t) + f_2\left(\frac{T}{4} + t\right) \qquad \ldots\ldots\ldots\ldots(5)$$

$$2\phi_3(t) = f_2(t) - f_2\left(\frac{T}{4} + t\right) \qquad \ldots\ldots\ldots\ldots(6)$$

(5) represents $C + \Sigma B_{4n} \cos 4n\omega t$, and (6) $\Sigma B_{4n+2} \cos (4n + 2)\omega t$. The author also gives formulæ which can be used for calculating the first ten harmonics without the necessity of decomposing the curve further than (1) and (2) above. A. R.

334. *Tension and Magnetostriction.* **K. Honda** and **S. Shimizu.** (Phil. Mag. 4. pp. 338–346, Sept., 1902.)—The apparatus for measuring the changes in length is in principle the same as that described by Nagaoka in his original paper (Phil. Mag., 1894), and used by him in his subsequent work. There are, however, points of difference; the expanding rod, instead of tilting a small optical lever by pushing forward one of its three feet, rolls a cylinder which rotates on agate centres. This cylinder carries a mirror, so that a beam of light may be deflected and a spot move on a scale. By suitable adjustment the cylinder can be so pressed tangentially against the cylinder that any movement of the former is taken up by the latter. By the arrangement used the authors claim to measure any movement more than $2{\cdot}7 \times 10^{-7}$ of the length of the rod. Results are given for specimens of soft iron, wolfram steel, nickel, and nickel steel. Besides plotting field against change in length, and drawing curves, in each of which tension is constant, the authors plot tension against change in length, and give curves for various values of field. The latter curves are interesting as showing that the effect of loading is in general not proportional to load. P. E. S.

335. *Magnetic Properties of Alloys of Iron.* **W. F. Barrett, W. Brown,** and **R. A. Hadfield.** (Roy. Dublin Soc., Trans. 8. pp. 1–22, Sept., 1902.)—Some of the same ground has been traversed in a previous paper [see Abstract No. 1721 (1902)], but fuller details are now given. The chemical analyses, annealing and magnetic measurements seem to have been conducted in a most exhaustive and thorough way. There are two parts to the paper. I. *Alloys nearly or quite non-magnetic.* A table given by the authors shows how the intensity for a given field varies with the composition. Small percentages of manganese or nickel added to iron cause an enormous drop in permeability, and if they both are added to iron the result is even more striking. High manganese and high nickel-and-manganese steels have peculiar properties, acting in an exactly opposite way to ordinary steel as regards annealing and quenching after heating. Thus there seem possibilities of obtaining a steel of high tensile strength, easily machined, and yet non-magnetic. The commercial importance of such a substance is obvious, *e.g.*, in non-magnetisable ships, clocks, watches, &c. II. *Alloys more magnetic than soft iron.* There are two classes, the silicon and aluminium alloys; the latter have the more extraordinary properties. When 2·25 per cent. of aluminium is included the alloy has $\mu = 9{,}000$ for



a field 0·5 c.g.s., whereas for the same field the value for Swedish iron is $\mu = 2{,}500$. The extraordinary magnetic softness of these alloys is shown by the following table:—

Swedish iron	35, reversed	15
Silicon-iron alloy	68, „	58
Aluminium-iron alloy	90, „	90

Thus when the rod of iron is placed vertically in the earth's field the deflection of the magnetometer near it is 35; on reversing the rod without any jar the deflection is 15 *in the same direction,* and so on for the other rods. Now for these rods, whose length is over 400 diameters, the demagnetising factor is negligible; hence the aluminium alloy is seen to be magnetically wonderfully soft. As regards hysteresis losses, it is found that both the silicon and aluminium alloys are economically much superior to iron or to "Lohy" iron, which is a substance specially used in transformers. As to explanation, the authors suggest that as silicon and aluminium have special affinity for oxygen they may reduce the iron into a specially pure state or else absorb occluded gases and so render the material less honeycombed with vesicles. P. E. S.

336. *Magnetostriction of Steel, Nickel, Cobalt, and Nickel Steels.* **H. Nagaoka** and **K. Honda.** (Phil. Mag. 4. pp. 45–72, July, 1902.)—In the authors' former experiments the nickel ovoid used was not quite homogeneous, and the cobalt ovoid was imperfect. The present experiments were made to study magnetostriction in more homogeneous metal, in cobalt, both cast and annealed, and in nickel steels. The results are summarised as follows :— The magnetisation of cast cobalt is nearly double that of the annealed; the latter has a high differential susceptibility. The magnetisation of 46 per cent. reversible nickel steel is between iron and cast cobalt, while that of 36 per cent. nickel is nearly the same as in cobalt. That of 29 per cent. nickel is nearly half that of nickel, and 25 per cent. nickel steel is only feebly magnetic. The course of the magnetisation curve of nickel steel resembles that of nickel. In cast cobalt, mechanical elongation in the direction of magnetisation produces diminution of magnetisation in low fields, which gradually lessens as the field strength is increased. Ultimately there is increase of magnetisation by elongation. Thus there is a critical point in cobalt which is opposite in character to the Villari point in iron. In annealed cobalt, mechanical elongation in the direction of magnetisation produces diminution of magnetisation, which increases with the field. In nickel steel mechanical elongation produces increase of magnetisation. Cast cobalt contracts in low fields up to $H = 130$, returns to its original length at $H = 740$, and then elongates slowly. Annealed cobalt contracts without showing a minimum up to $H = 1{,}800$. These effects stand in reciprocal relation with the effect of mechanically elongating cobalt. Nickel steel elongates by magnetisation. The character of the change is similar to that in nickel, but the sense is different. The rate of change in high fields is greater in 29 per cent. nickel than in 36 per cent. nickel, in which it is again greater than in 46 per cent. nickel. Nickel steel elongates to a greater degree in the annealed than in the hard-drawn state. Iron, steel, nickel, and nickel steel increase in volume by magnetisation, but cobalt contracts. Cast cobalt contracts rapidly in low fields, reaching a minimum at $H = 900$, after which it expands. Annealed cobalt contracts continuously as the field increases. The increase of volume in nickel steels is almost proportional to the field. The increase becomes greater as the percentage of nickel is less. The increase in 29 per cent. nickel is nearly 40 times that in iron. The twist produced by the combined action of circular or longitudinal magnetisation in iron, nickel, and nickel steel increases with the longitudinal field strength, and reaches a maximum. The sense of twist in iron and nickel steel is opposite to that in nickel. The reciprocal effect holds. G. H. B.

337. *Secular Variation of Magnetic Declination at Zi-ka-wei.* **J. de Moidrey.** (Terrestrial Magnetism, 7. pp. 128–130, Sept., 1902.)—The object of the paper is to further substantiate the statement, made in 1898, that the Zi-ka-wei records of secular variation in declination show minima for 1878, 1888, and 1898. The author gives the annual declination means both for January 1 and July 1, taking in each case the six months before and the six months after the date, and his secular variations are the differences between these successive means. Reference is made to H. Fritsche's analysis of the magnetic observations, conducted at Pekin in 1870 to 1883, which yields similar curves. H. B.

338. *Lunar Period of the Diurnal Oscillation of Magnetic Declination.* **J. de Moidrey.** (Terrestrial Magnetism, 7. pp. 125–127, Sept., 1902.)—The author examines the midday declination records of Zi-ka-wei, in China, for the twenty-two years, 1877 to 1899, with regard of the age of the moon, obtaining 250 groups of 30 days; 29·53 days is the real length of the lunar month. The deviations from the mean value plotted out for the days 0 to 29 give a fairly regular amplitude curve with two minima, two days after the quadratures, and two maxima, two or three days after the syzygies. The minimum following the last quarter is deeper than the other; the two maxima are equal. H. B.

339. *Magnetic Observations in Egypt,* 1898–1901. **H. G. Lyons.** (Roy. Soc., Proc. 71. pp. 1–25, Oct. 17, 1902.)—The observations were made at different periods with different instruments, a declinatorium by Bamberg, a Kew magnetometer, and a Dover dip circle, and they are grouped according to periods and instruments. In addition to the observations made at various stations, particulars of which are given, in Egypt proper, some work was also done in 1901 on the Upper White Nile and Bahr el Jebel, from Khartum up to Gondokoro, whenever opportunity offered, in connection with the investigation of the discharge of the Nile and its tributaries. H. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

340. *Plant Growth and Ionisation of the Soil.* **A. B. Plowman.** (Amer. Journ. Sci. 14. pp. 129–132, Aug., 1902.)—Negatively charged ions stimulate, while positive paralyse and kill embryonic protoplasm. The side of a plant exposed to negative ions in a current of electricity grows faster than the opposite side, and the root-tip curves towards the anode. The plant body is normally electropositive to the soil in which it grows, and attracts the negative ions of the soil. A. D.

341. *Phototherapy, Röntgen Rays and High-frequency Discharges.* **L. Freund.** (Röntgen Ray, Archives, 7. pp. 22–24; Discussion, pp. 24–25, July, 1902.)—In phototherapy not only the ultra-violet rays, but also the violet, the blue, the yellow, and the red rays may be used. The beneficial effect of Finsen's lamp on lupus cannot be due to ultra-violet rays, as these are deficient in penetration. In the treatment of lupus it is useful to use the Röntgen rays for large areas, and later to finish off any obstinate points by the Finsen lamp. The high-frequency treatment is useful only upon surface conditions and acts as a brush discharge. H. L. J.

342. *Production of Sleep and of General or Local Insensibility to Pain by Electric Currents.* **S. Leduc.** (Comptes Rendus, 135. pp. 199–200, July 21, 1902.)—An animal is placed in circuit with a source of direct current, the contacts are by means of metal plates wrapped in cotton moistened with dilute salt solution, the anode is applied to the skin of the lower part of the back, the kathode to the head, the hair being first removed from the parts by shaving. The current is interrupted at the rate of 150 to 200 times a second

by an interrupter without self-induction, and at the commencement it is rapidly raised until general muscular contractions are set up. (A pressure of 12 to 30 volts and a current of from 2 to 10 milliamperes are required according to the size of the animal.) The animal falls on its side, and breathing movements cease, the current is then reduced until breathing recommences, when the animal passes into a tranquil sleep with regular pulse and respiration, but with the functions of the brain suspended. The muscles are relaxed and a pinch, a prick, or a cutting operation provoke no response except slight reflex movements. The state may be maintained for as long as two hours. The return to consciousness is sudden. As soon as the current is cut off the animal jumps up and gambols joyously. No bad effects are apparent, on the contrary dogs seem more gay and lively afterwards. The switching on of the current does not seem to be painful, the animals make no effort to resist or to escape. If the current at the commencement is not made strong enough to cause general muscular contractions and arrest of breathing the stage of deep sleep can be produced, but it takes a longer time and seems more disagreeable to the animal. A single nerve trunk can be made insensible in a similar way by placing the kathode upon the skin lying over it. H. L. J.

REFERENCES.

343. *The Property of Electric Conductivity in Metals, Alloys, and Dissolved Electrolytes.* **R. Mewes.** (Elektrochem. Zeitschr. 9. pp. 36–42, May; 63–67, June; and pp. 80–89, July, 1902.)—A general, non-experimental discussion of the subject. D. H. J.

344. *Regulation of High-Frequency Electric Resonators.* **H. Guilleminot.** (Comptes Rendus, 135. pp. 288–290, Aug. 4, 1902.)—A coil of variable self-induction consisting of 15 turns of thick copper wire is placed in series with the primary circuit, and more or fewer turns are short-circuited in order to obtain the best adjustment. Striking results were obtained with an Oudin resonator. The above was done with a view to its medical application. G. E. A.

345. *Electrical Charges.* **V. Crémieu.** (Comptes Rendus, 135. pp. 153–155, July 21, 1902.)—The author describes certain phenomena of disymmetry as between positive and negative charges on metallic coatings on solid dielectrics. Magnetic disturbances displacing and demagnetising astatic magnetic needles placed at a node of electric oscillations are also described. A. D.

346. *Thunder Signalled at a Distance.* (Revue de l'Él., Berne, 11. pp. 106–107, July 31, 1902.)—Account is given of experiments made by Boggio Lera in the Catania Observatory. Thunder-claps 1,000 km. away are registered in his apparatus. Weather forecasts can be made in accordance with the readings. A. D.

347. *Measurement of Alternating Potentials.* **C. Carpini.** (Accad. Lincei, Atti, 11. pp. 98–102, Aug. 3, 1902.)—The author extends to alternating high potentials the method of measuring by observing the deformations of a conducting liquid surface put to earth, under a charged ball. [See Abstract No. 877 (1902).] The effect of capillarity is not negligible. A. D.

348. *Discharge through n Wires in Parallel.* **A. Garbasso.** (Ann. d. Physik, 8. 4. pp. 890–897, July, 1902.)—A mathematical paper, developing the various equations. A. D.

349. *High Electrical Resistances.* **O. N. Rood.** (Amer. Journ. Sci. 14. pp. 161–165, Aug., 1902.)—The author continues his researches [see Abstracts Nos. 110 and 2168 (1901)], and applies them to the measurement of the electric resistance of glass, quartz, mica, ebonite, and gutta-percha. Provisional data are given. A. D.

350. *Discharge of Tesla Currents from Points.* **K. v. Wesendonck.** (Phys. Zeitschr. 3. p. 462, July 15, 1902.)—Referring to Möhlmann's paper [see Abstract No. 84 (1903)] the author expresses the opinion that there is still something special about the Tesla discharges, and refers to the experiments described in his paper [see Abstract No. 274 (1899)]. D. H. J.

351. *Disturbance of Compasses on a Ship.* **H. Meldau.** (Phys. Zeitschr. 3. pp. 391–395, June 1, 1902.)—A theoretical investigation of the forces acting on a compass in terms of the components of (1) the earth's magnetism, (2) the ship's permanent magnetism, (3) the ship's sub-permanent magnetism. P. E. S.

352. *Influence of Temperature on Ionisation by Collision.* **J. Stark.** (Ann. d. Physik, 8. 4. pp. 829–841, July, 1902.)—This paper is a continuation of previous theoretical papers [see Abstracts Nos. 845 (1901) and 1378 and 1898 (1902).] The effects produced by change of temperature are discussed, and the results obtained are applied to the explanation of known properties of the discharge of electricity through gases. W. E. T.

353. *Magnetism of Iron and Steel at Low Temperatures.* **C. C. Trowbridge.** (Elect. World and Engineer, 40. pp. 325–328, Aug. 30, 1902.)—A summary of results obtained up to date, principally by Dewar and Fleming. [See also Abstract No. 1554 (1902).] P. E. S.

354. *Skin Currents, III. The Human Skin.* **A. D. Waller.** (Roy. Soc., Proc. 70. pp. 374–391, Aug. 9, 1902.)

355. *Interpretation of Photographic Records of the Response of Nerve obtained with the Capillary Electrometer.* **G. J. Burch.** (Roy. Soc., Proc. 70. pp. 194–221, July 8, 1902.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

356. *Calculating Atomic Weights.* **F. W. Clarke.** (Zeitschr. Anorg. Chem. 32. 2. pp. 219–227, Sept. 15, 1902.)—The usual method of calculating atomic weights may give rise to uncertainties greater than is generally supposed, as all the individual experimental errors are accumulated in the final result. According to the manner of accounting for the errors, these uncertainties may be as high as ± 0·02 in some cases. The author therefore suggests combining several ratios with one another, so as to minimise the influence of each of the errors. In order to illustrate his views, he combines thirty ratios, each of which includes the atomic weights of silver, chlorine, bromine, iodine, nitrogen, sodium, and potassium, into seven normal equations, where these constants enter as unknown quantities. Taking $O = 16$, and $H = 1·0079$, and applying the method of least squares, the following values are found by resolution: $Ag = 107·9525$, $Cl = 35·4521$, $Br = 79·9687$, $I = 126·8663$, $N = 14·0527$, $Na = 23·0636$, $K = 39·1573$. These figures, except for chlorine, are all very much higher than any one of the values contained in the tables derived from Stas's work. Taking the ratio oxygen : hydrogen as the basis of our system of atomic weights, determining these seven fundamental constants would be analogous to performing a first triangulation. The author, far from considering his values as definite, points out the all-importance of accuracy in this fundamental work, and maintains that, on the basis of the work done by Stas and Marignac, the solution of this problem is not likely to offer any serious difficulties. A. G.

357. *Action of Sulphur on Toluol and Xylol.* **L. Aronstein** and **A. S. van Nierop.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 298–305, Sept. 27, 1902.)—The molecular weight of sulphur in liquids, the boiling-points of which range between 45° and 214° C., has been found to be in accord with the formula S_8. If, however, either toluol or xylol are used as solvents, the values found are intermediate between S_7 and S_8. The authors investigate the chemical causes of this phenomenon, it being found that the products of reaction between the above liquids and sulphur are such as to give rise to a divergence in the stated sense, even in the case of but a slight reaction occurring. In fact, one molecule of sulphur will produce 8 sulphuretted hydrogen and 4 stilbene molecules. Now, though the former, being volatile, will escape for the most part, on the liquid being boiled, yet the increase in the number of molecules is so great as to account fully for the phenomena observed. The fact that the divergence is greater in the case of toluol than in that of *m*-xylol is equally in accord with the result found by the authors that more sulphuretted hydrogen is evolved in the former case. A. G.

358. *Preparation of Pure Chlorine and its Behaviour towards Hydrogen.* **J. W. Mellor** and **E. J. Russell.** (Chem. Soc., Journ. 81. and 82. pp. 1272–1280, Sept., 1902.)—Details are given of the preparation of pure chlorine by the electrolysis, in a V-shaped tube and using carbon electrodes, of fused silver chloride, foreign gases and moisture being removed by reversing the current and repeatedly exhausting by means of a Sprengel pump. The silver tree formed during the electrolysis may be fused or broken up by raising the temperature and increasing the strength of current. The hydrogen employed in the experiments was prepared by the action of sodium on steam, the gas being then absorbed by palladium and the metal afterwards heated in a vacuum.

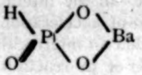
The interaction of the two gases is carried out by introducing one into the inner, and the other into the outer, bulb of a glass condenser commonly used with a Soxhlet extraction apparatus; after drying for some months in the dark in presence of phosphorus pentoxide, the inner bulb is broken by means of a piece of glass rod in it, and the gases allowed to mix.

The experiments show that such a mixture is exploded by a small electric spark, the two gases completely uniting; drying has, therefore, no apparent influence on the action of the electric spark. Mixtures of moist hydrogen and chlorine explode at about 260°, but on heating the purified gases for some minutes at 270°, neither explosion nor combination takes place. When heated to 450° for 10 minutes, no explosion occurs, but about 80 per cent. of the gases combine; in this case, however, the combination may be due to surface action brought about by the volatilisation of the phosphorus pentoxide. Bright sunshine acting for three days causes about 30 per cent. of the gases to combine. T. H. P.

359. *Union of Hydrogen and Chlorine. Period of Induction.* **J. W. Mellor.** (Chem. Soc., Journ. 81. and 82. pp. 1292–1301, Sept., 1902.)—In this paper the author gives the results of investigations on the so-called period of induction—the period during which the velocity gradually increases from zero to a final maximum value—in the interaction of hydrogen and chlorine. The existence of such a period of acceleration in chemical reactions has been explained as due to the fact that an intermediate compound is formed, which gradually disappears by reason of its reaction with a proportional quantity of a third substance. The author shows that if the reaction between hydrogen and chlorine in the presence of moisture is assumed to take place with the formation of such an intermediate compound, the period of induction is a direct consequence of the law of mass action. Experiments show that neither chlorine monoxide nor hypochlorous acid abbreviates the period of induction, so that neither of these substances can act as intermediate compounds in the reaction between hydrogen and chlorine. Since chlorine acquires no appreciable chemical activity by exposure to sunlight, the presence of hydrogen as well as of moisture determines the greater chemical activity of an induced mixture of hydrogen and chlorine gases. If an intermediate compound takes part in the reaction between hydrogen and chlorine in the presence of moisture, the most probable compound satisfying the required conditions contains $x\,Cl_2$, $y\,H_2O$, $z\,H_2$, where x, y, and z are positive integers. T. H. P.

360. *Kinetics of Photochemical Reactions.* **E. Goldberg.** (Zeitschr. Phys. Chem. 41. pp. 1–10, June, 1902.)—The oxidation of quinine sulphate by chromic acid proceeds to a considerable extent in the light, yet in the dark is so small as to be negligible; the extent of oxidation at any time can be readily ascertained by running a certain volume of the reaction mixture into potassium iodide and titrating with sodium thiosulphate. Only blue, violet, and the neighbouring ultraviolet rays are effective—in accordance with Vogel's rule that only absorbed rays can be chemically active. In accordance with Bunsen and Roscoe's law, the chemical action is, for a given kind of light, proportional to the intensity and duration of the illumination. In this as in many other photochemical processes, the temperature coefficient of the velocity constant of the reaction is small. The oxidation of quinine is apparently a unimolecular action, but is really, when allowance is made for the variation of the light-intensity with the concentration, bimolecular. The author gives reasons for his view that photochemical action in the light is essentially different from photochemical action in the dark. D. H. J.

361. *Structural Isomerism of Salts.* **A. Hantzsch.** (Zeitschr. Elektrochem. 8. p. 484; Discussion, pp. 484–485, July 24, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902.)—The author discusses the two isomeric mercury salts of cyanuric acid, and endeavours to show that their isomerism is due to a difference in structure. The normal or "oxygen" salt $(CN)_3(OHg)_3$, is prepared from sodium cyanurate and mercury salts at 0° C., and is easily split up by alkalies into mercuric oxide and sodium cyanurate. On the other hand, the "nitrogen" salt $(CO)_3(NHg)_3$ is formed similarly at 100° C., and also exclusively by the action of cyanuric acid on acetate of mercury. This salt is scarcely attacked by alkalies. It is remarkable that the two salts, when once isolated, are stable; the labile "oxygen" salt showing no tendency to change into the stable "nitrogen" form. Similar, but not so striking, differences are shown by the phosphites of barium and mercury. The "active" barium phosphate, prepared in the cold, reduces silver nitrate, while that prepared at 100° C. only reacts extremely slowly. The first has perhaps the "Aldehydic" formula—



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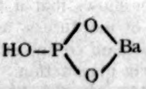

A discussion followed in which **van't Hoff** and **Hantzsch** took part.
W. C. B.

362. *Minimum Critical Temperature in Ternary Systems.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 285–295, Sept. 27, 1902.)—The author has already, in his Molecular Theory, established the conditions necessary for the existence of a minimum critical temperature for a binary system. (See "Continuïteit, &c.," II. p. 20). On the form of state equation, as adopted by him, it is found that $RT_{cr} = 8a_x/27b_x$, T_{cr} being the temperature for which the isothermal will show a coincident maximum and minimum. It is shown that, in the case of a binary system, the critical phenomena, though different from those observed with a single substance, will diverge so little from the latter that the above equation represents fairly well the experimental facts, provided T_{cr} be a minimum. Now, in the case of ternary systems, the same is noted. Though diverging to a higher degree from what is observed for a single substance, than binary systems do, their behaviour is found to be very much the same. In order to apply the author's theory to ternary systems, a_{12}, a_{13}, and a_{23} must be given. But these are derived from the theory of binary systems, no additional data being required. A. G.

363. *Method for Producing Ammonium-Lead Tetra-Chloride.* **K. Elbs.** (Zeitschr. Elektrochem. 8. pp. 512-513; Discussion, pp. 513-514, July 31, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902.)—Following up former investigations [see Abstract No. 584 (1901)], the author finds that by using a lead and carbon anode simultaneously in an electrolyte of HCl, $PtCl_4$ can be prepared, and isolated as an ammonium double salt by the addition of NH_4Cl. O. J. S.

364. *Chemistry of Cuprous Compounds.* **G. Bodländer.** (Zeitschr. Elektrochem. 8. pp. 514-515, July 31, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902).—This is an investigation as to whether cuprous ions are mono- or di-atomic. The experiments prove the mono-atomic nature of cuprous ions. Figures and formulæ are given in a short paper. [See also Abstract No. 1752 (1902).] O. J. S.

365. *The Antiseptic Function of the H Ions of Dilute Acids.* **M. Bial.** (Zeitschr. Phys. Chem. 40. pp. 513-534, May 13, 1902.)—The author continues Dreser's and Paul and Krönig's work, and shows that the antiseptic action of a series of acids increases with the amount of dissociation, and that consequently the introduction of neutral salts into the solution by modifying the amount of dissociation, causes a corresponding alteration in the antiseptic action. S. R.

366. *Action of Currents of High Voltage on Bromine.* **K. Kellner.** (Zeitschr. Elektrochem. 8. pp. 500-502; Discussion, pp. 502-504, July 24, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902.)—The author, having previously shown that pure dry chlorine is altered in properties after having been exposed to the action of a high potential current, examines the action of similar currents on bromine, iodine, and sulphur. By the above treatment chlorine becomes more active; for instance, it possesses the power of forming chloracetic acid in the dark. The bromine used was "chemically pure" from Merck; this was further purified by Pierre's process, and then fractionally distilled, the middle fractions only being used. The pure dry bromine vapour was distilled into "ozone" tubes from which the oxygen had been pumped out, the last traces being driven out by bromine vapour. The tube was then placed in a vessel containing water made slightly acid, the inner tube also being filled with the dilute acid. The bromine was thus contained in the closed space between the two layers of acid. The current was one of 50 volts, frequency 45, transformed to 12,000-14,000 volts by a Tesla induction-coil; then to 250,000 or 300,000 by a Tesla oil-transformer. When this current was passed between electrodes in the two layers of acid the bromine became gradually changed into a layer of sulphur-yellow crystals which lined the tube. By distillation of the bromine from one vessel to another during the action of the current, the author proved that the change was not due to any impurity in the bromine. The composition of the yellow substance was not ascertained; the author regards it as an allotrope of bromine. A discussion followed, in which it was suggested that the compound might be due to the action of the bromine on the glass of the apparatus; the glass used for the apparatus was free from lead. W. C. B.

367. *Relation between Current and Electrolytic Effects.* **Berthelot.** (Comptes Rendus, 135. pp. 5-8, July 7, 1902.)—The author's previous experiments relate to cells, of which the e.m.f. is considerably greater than that necessary to electrolyse acidulated water; in the present series of experiments the e.m.f. current and electrolytic action of cells having an e.m.f. only very slightly greater than the back e.m.f. of the voltmeter are measured. The cells used contained in the inner porous pot 50 c.cm. of ½ normal NaOH, to which had been added 10 c.cm. of pyrogallol solution ($C_6H_6O_3$ in 5 litres); the outer pot containing 250 c.cm. of sodium chloride solution (NaCl in 5 litres), with 10 c.cm. of hydrogen peroxide (H_2O_2 in 5 litres). The e.m.f. of these cells was found to be 0·86 volt. With a current of 0·00001 ampere, and an e.m.f. of 0·1 volt, the electrolytic action did not become visible until the pressure was reduced to 8 mm.; corresponding with a production of about 0·000006 mg. of hydrogen per minute. An excess of 0·03 volt over the back e.m.f. is sufficient to determine a visible electrolysis. W. C. B.

368. *Furnaces Electrically Heated by Means of Platinum Foil.* **E. Haagn.** (Zeitschr. Elektrochem. 8. pp. 509–511; Discussion, p. 512, July 31, 1902. Paper read before the German Electrochemical Society at Würzburg, May 9, 1902.)—This mode of applying resistance-heating by means of platinum foil surrounding the object to be heated, according to the author offers advantages over wire applied in the same manner, as it is cheaper and more efficient. A temperature of 1,700° C. was reached, at which point porcelain tubes surrounded by the platinum foil softened. The author further enumerates the various uses these furnaces can be put to. Useful information as to prices, dimensions, current consumption, and temperature obtainable is given at the end of the paper. O. J. S.

REFERENCES.

369. *A Table of Atomic Weights of Seventy-seven Elements.* Compiled in April, 1902, from the most recent data. **T. W. Richards.** (Amer. Acad., Proc. 37. pp. 630–631, Aug., 1902.)

370. *Inorganic Colloids.* **A. Gutbier.** (Zeitschr. Anorg. Chem. 32. 3. pp. 347–357, Oct. 23, 1902.)—The author has applied his method, previously used to obtain gold in the colloidal state, to numerous other elements, and he succeeds in converting into this state nearly all the elements so far known as colloids, as well as numerous elements not yet known in this state. [See also Abstract No. 2105 (1902).] A. G.

371. *Velocity of Reaction before Complete Equilibrium, &c., Part II.* **M. Wilderman.** (Phil. Mag. 4. pp. 270–277, Aug., 1902.)—This paper does not appear to contain any new matter, but to consist of further remarks on the formulæ developed by the author for the cases where the real equilibrium-point does not coincide with the purely thermal equilibrium-point. Such cases occur in the experimental determination of freezing- and boiling-points, vapour-pressures, solubilities, &c. Their theory was first given by Nernst and Abegg, but since then the subject has been extended both experimentally and theoretically by the author. [See also Abstract No. 2207 (1901).] F. G. D.

372. *The Melting of Carbon.* **A. Ludwig.** (Zeitschr. Elektrochem. 8. pp. 273–281, May 8, 1902.)—An account of many experiments carried on over a number of years for the purpose of converting carbon into diamonds by means of very high pressures and the use of the electric current. O. J. S.